URBAN RUNOFF DISCHARGES FROM SACRAMENTO, CALIFORINA

1984-85

CVRWQCB REPORT NUMBER 87-1SPSS

California Regional Water Quality Control Board

Central Valley Region

Standards, Policies, and Special Studies Section

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URBAN RUNOFF DISCHARGES FROM SACRAMENTO, CALIFORNIA

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by

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TABLE OF CONTENTS

I. CONCLUSIONS

1. Urban runoff water from Sacramento proper was discharged to the Sacramento and American rivers during every month of fiscal year 1984-85. Slightly less than half the water discharged was not directly attributed to precipitation.

2. Sacramento urban runoff water and sediments containing copper, lead, zinc, cadmium, and chromium, at concentrations typically exceeding U.S. EPA water quality criteria (to protect freshwater aquatic biota), are discharged to the Sacramento and American rivers untreated.

3. Urban runoff from Sacramento made up a larger portion of the Sacramento River at Freeport than treated wastewater from the Sacramento Regional treatment plant during every month of FY 1984-5.

4. Urban runoff discharges are increasing as open land areas in Sacramento continue to be developed.

5. Mass loading estimates of certain trace metals from Sacramento urban runoff discharges were several times higher than similar estimates computed for Sacramento Regional treatment plant secondary effluent.

6. Polynuclear aromatic hydrocarbons (PAH) are the most prevalent organic priority pollutants discharged from stormwater drains around Sacramento and appear to be a major contributer to downstream sediment levels.

7. Pesticide detection in urban runoff water is rare as is Sacramento City data concerning these constituents.

8. Volatile organic chemicals (VOC) have not been found in urban runoff from predominantly residential areas around Sacramento although several VOCs have been found in runoff from two industrial type watersheds.

II. SUMMARY

This report describes the results of a runoff study conducted in the Sacramento urban area. The purpose of the study was to estimate discharge volumes and loads of key pollutants in order to assess whether the discharges could pose a threat to beneficial uses in the discharge area and downstream.

Sacramento was ideal for this study because of the levee system surrounding the City. When it rains, water is typically piped through an underground conveyance system to a sump where it is pumped to the American or Sacramento Rivers. The water pumped over the levees is measured by pump run time. These pumpage values were used to calculate the volume of water discharged as urban runoff (UR) for a year's period. Correlating these volumes with rainfall indicated that slightly more than half the water pumped during the year was directly the result of rainfall input. The remainder is discharged during periods of dry weather. Some dry weather sources include commercial and domestic irrigation, general washoff, groundwater infiltration, and illegal discharges.

Urban runoff/Sacramento River dilution ratios ranged from 1 to 3 percent, which indicates that the Sacramento River was made up of at least 1 percent Sacramento UR during the year.

The most common priority pollutants found in UR are the trace metals copper, lead, zinc, and to a lesser extent cadmium, chromium, arsenic, and nickel. Metals concentrations in UR typically exceed U.S. EPA water quality criteria to protect freshwater biota. Metals in UR originate primarily form automobile wear. For example, lead comes from exhaust fumes and tire wear, zinc and copper are components of brake shoes, and most metals can be found in used crankcase oil. Other sources of metals input include atmospheric fallout, metallic corrosion, and illegal discharges.

Mass loads were calculated for copper, lead, and zinc because of their large presence downstream and the substantial concentration data available on these compounds necessary for accurate loading calculations. The annual loads were compared to the Sacramento Regional County Sanitation District's wastewater treatment plant loads for the same year. The loads of copper, lead, and zinc in UR from Sacramento exceeded loads similarly calculated for the wastewater treatment plant. This is significant since the treatment plant is the second largest volume NPDES (National Pollutant Discharge Elimination System) discharger in the Central Valley.

The findings of this report indicate that UR from Sacramento, and probably other cities in the Central Valley as well, are significant contributers of pollutants to waters where they are discharged and downstream to the Delta. Furthermore, storm drain discharges were observed to be toxic to test organisms in the American River during a storm event (Foe, pers. comm.). Regional Board staff are presently working with Sacramento City and County staff to develop a monitoring program to be implemented in future management strategies.

III. DESCRIPTION OF THE SACRAMENTO URBAN STORM DRAIN SYSTEM

Urban runoff (UR) water from greater Sacramento (City and County jurisdiction) is discharged to the Sacramento and American Rivers via a series of flood control pumps and gravity flow conveyances. The major characteristics of the Sacramento drainage system are shown in Figure 1 and Table 1. The American River receives UR input from approximately 32 point source locations (41,856 acres) while the Sacramento River is the receiving water for 12 discharges (109,173 acres). Water must be pumped to the rivers where levees are present or when the American River reaches a critical high flow stage. Levees are present along the Sacramento River and are present along the American River upstream from the Sacramento River confluence to Goethe Park. Jurisdiction over the operation of the drainage and pumping systems is divided among six local agencies: the City and County of Sacramento and the Yolo County Department of Public Works, the American River Flood Control District, California State University at Sacramento, and California Reclamation District 1000 (RD1000).

The greater Sacramento storm drainage infrastructure is sectioned into 45 watersheds, most of which can generally be classified as a combination of residential, commercial, open, and industrial land-use types. Several watersheds drain to canals that also

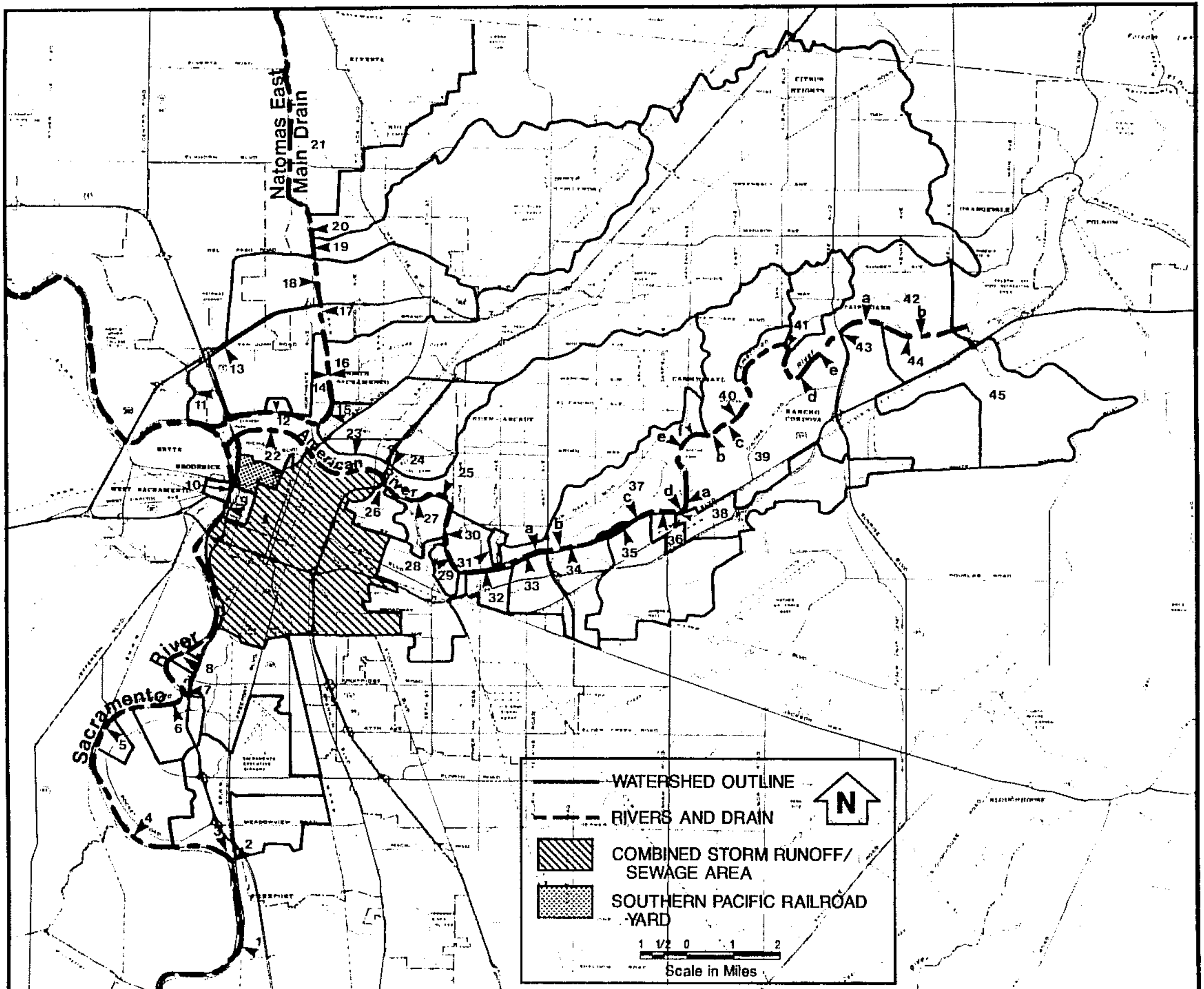

Figure 1. SACRAMENTO (CA) STORM DRAIN SYSTEM (SEE TABLE 1 FOR MAP I.D. Nos.)

TABLE 1. MAJOR CHARACTERISTICS OF THE SACRAMENTO AREA URBAN STORM DRAIN SYSTEM. (1)

MAP I.D. NUMBER (2)	DISCHARGE RECEIVING WATERS	DRAINAGE TITLE	OPERATIONS DRAINAGE (3)	OPERATIONS DISCHARGE (4)	APPROX. ACREAGE	(P)UMP OR (G)RAVITY DISCHARGE	MAXIMUM PUMP CAPACITY (GPM)
1	SACRAMENTO RIVER (9)	SUMP 90 (5)	CITY/COUNTY	CITY	90872	P	49500
2	SACRAMENTO RIVER	SUMP 34	CITY	CITY	470	P	75000
3	SACRAMENTO RIVER	SUMP 28	CITY	CITY	3760	P	144000
4	SACRAMENTO RIVER	SUMP 132	CITY	CITY	1340	P	31300
5	SACRAMENTO RIVER	SUMP 70	CITY	CITY	240	P	21400
6	SACRAMENTO RIVER	SUMP 63	CITY	CITY	1100	P	32000
7	SACRAMENTO RIVER	SUMP 104	CITY	CITY	2220	P	250750
8	SACRAMENTO RIVER	SUMP 41	CITY	CITY	80	P	2400
9	SACRAMENTO RIVER	SUMP 52	CITY	CITY	190	P	34200
10	SACRAMENTO RIVER	WEST SACRAMENTO	COUNTY (YOLO)	COUNTY(YOLO)	100	P	6000
11	NATOMAS MAIN DRAIN (6)	SUMP 130	CITY	CITY	443	P	97500
12	NATOMAS EAST MAIN DRAIN (7)	SUMP 58	CITY	CITY	70	P	23900
13	NATOMAS EAST DRAIN	SUMP 129	CITY	CITY	2252	P	256900
14	NATOMAS EAST MAIN DRAIN (7)	SUMP 102	CITY	CITY	350	P	62750
15	NATOMAS EAST MAIN DRAIN (7)	ARFCD PUMP 3	CITY	ARFCD	210	P	33663
16	NATOMAS EAST MAIN DRAIN (7)	ARCADE CREEK	CITY/COUNTY	CITY	24980	G	---
17	NATOMAS EAST MAIN DRAIN (7)	ARFCD PUMP 7 (MAGPIE CREEK)	CITY/COUNTY	ARFCD	2964	P	336626
18	NATOMAS EAST MAIN DRAIN (7)	C-1 CANAL	RD1000	RD1000	1610	P	?
19	NATOMAS EAST MAIN DRAIN (7)	LINDA CREEK	CITY/COUNTY	CITY	9498	G	---
20	NATOMAS EAST MAIN DRAIN (7)	DRY CREEK	CITY/COUNTY (8)	CITY	89470	G	---
21	NATOMAS EAST MAIN DRAIN (7)	NATOMAS EAST	COUNTY	COUNTY	7520	G	---
22	AMERICAN RIVER	SUMP 111	CITY	CITY	419	P	93100
23	AMERICAN RIVER (9)	ARFCD PUMP 1	CITY	ARFCD	895	P	125674
24	AMERICAN RIVER (9)	ARFCD PUMP 2	CITY	ARFCD	1570	P	291743
25	AMERICAN RIVER	CHICKEN AND STRONG RANCH SLOUGHS	COUNTY	COUNTY	9430	P/G (10)	534114
26	AMERICAN RIVER	SUMP 99	CITY	CITY	480	P	88900
27	AMERICAN RIVER	SUMP 10	CITY	CITY	660	P	48000
28	AMERICAN RIVER	SUMP 101	CITY	CITY	1772	P	82560
	AMERICAN RIVER	ARFCD PUMP 5	CITY/ARFCD/CSUS	ARFCD	193	P	78546
29	AMERICAN RIVER	CSUS	CSUS	CSUS	238	P	?
30	AMERICAN RIVER	SUMP 95	CITY	CITY	562	P	95700
31	AMERICAN RIVER	SUMP 109	CITY	CITY	118	P	18000
32	AMERICAN RIVER	SUMP 91	CITY	CITY	350	P	37600
33	AMERICAN RIVER	SUMP 92	CITY	CITY	820	P	68000
34	AMERICAN RIVER	MANLOVE	COUNTY	COUNTY	1106	P/G (10)	80790
35	AMERICAN RIVER	NORTH MAYHEW	COUNTY	COUNTY	3199	P/G (10)	43088

continued on next page

TABLE 1, continued.

MAP I.D. NUMBER (2)	DISCHARGE RECEIVING WATERS	DRAINAGE TITLE	OPERATIONS DRAINAGE (3)	OPERATIONS DISCHARGE (4)	APPROX. ACREAGE	(P)UMP OR (G)RAVITY DISCHARGE	MAXIMUM PUMP CAPACITY (GPM)
36	AMERICAN RIVER	BRADSHAW	COUNTY	COUNTY	325	G	---
37A-B	AMERICAN RIVER	HAGGINBOTTOM	COUNTY	COUNTY	3390	P-G	---
A	AMERICAN RIVER	KADEMA	COUNTY	COUNTY	---	P/G (10)	26930
B	AMERICAN RIVER	WILHAGGIN	COUNTY	COUNTY	---	P/G (10)	35009
C	AMERICAN RIVER	HAGGINBOTTOM	COUNTY	COUNTY	---	P/G (10)	94255
D	AMERICAN RIVER	HAGGINBOTTOM	COUNTY	COUNTY	---	G	---
E	AMERICAN RIVER	HAGGINBOTTOM	COUNTY	COUNTY	---	G	---
F	AMERICAN RIVER	HAGGINBOTTOM	COUNTY	COUNTY	---	G	---
38	AMERICAN RIVER	BOYD	COUNTY	COUNTY	2151	G	---
39A-E	AMERICAN RIVER	RANCHO CORDOVA	COUNTY	COUNTY	4623	P-G	---
A	AMERICAN RIVER	WEST COLOMA	COUNTY	COUNTY	---	P/G (10)	11221
B	AMERICAN RIVER	RANCHO CORDOVA	COUNTY	COUNTY	---	G	---
C	AMERICAN RIVER	RANCHO CORDOVA	COUNTY	COUNTY	---	G	---
D	AMERICAN RIVER	SUNRIVER	COUNTY	COUNTY	---	P/G (10)	32316
E	AMERICAN RIVER	RANCHO CORDOVA	COUNTY	COUNTY	---	G	---
40	AMERICAN RIVER	CARMICHAEL CREEK	COUNTY	COUNTY	1854	G	---
41	AMERICAN RIVER	MINNESOTA CREEK	COUNTY	COUNTY	986	G	---
42A-B	AMERICAN RIVER	FAIR OAKS	COUNTY	COUNTY	2479	G	---
A	AMERICAN RIVER	FAIR OAKS	COUNTY	COUNTY	---	G	---
B	AMERICAN RIVER	FAIR OAKS	COUNTY	COUNTY	---	G	---
43	AMERICAN RIVER	BUFFALO CREEK	COUNTY	COUNTY	3328	G	---
44	AMERICAN RIVER	NIMBUS	COUNTY	COUNTY	907	G	---
45	AMERICAN RIVER	AEROJET (11)	COUNTY	COUNTY	4115	G	---

(1) Watersheds areas were reproduced from individual shed outlines provided by: Sacramento City and County Departments of Public Works; Yolo County Department of Public Works; American River Flood Control District (ARFCD); and California State University, Sacramento (CSUS) Plant Operations.

(2) See Figure 1.

(3) Watershed territory ("county" refers to Sacramento County, unless otherwise stated).

(4) Maintenance and operation of discharge pumps, or the territory of the discharge.

(5) Includes Morrison (64,000 acres)and Laguna (31,872 acres) Creek watersheds (Sacramento City, 1986).

(6) Natomas Main Drain is a gate-regulated discharge to the Sacramento River (River mile 61.3) that services approximately 55,100 acres of land primarily used for agriculture.

(7) Natomas East Main Drain is an unregulated discharge to the Sacraemento River (River mile 60.5) that services approximately 45,000 acres of commercial, residential, open, and industrial class land, as well as rural/agricultural land from east Natomas.

(8) Approximately 90% of this watershed lies within Placer County.

(9) Runoff is initially discharged to a retention basin.

(10) Surface runoff is discharged via gravity flow or pumps depending on the level of the American River.

(11) Aerojet land runoff is diverted to onsite retention ponds.

receive agricultural return flows as well as other discharge types. Urban runoff from north Sacramento is combined with agricultural runoff from the Natomas area within the Natomas Main and Natomas East Main drains. Furthermore, Natomas East Main Drain also receives input from 4 wastewater treatment plants discharging to the Dry Creek watershed (Roseville, Sabre City, and Placer County (2)). Sacramento City flood control pumping station no. 90 (sump 90) also discharges a combined matrix of water consisting of agricultural drainage, permitted NPDES effluent, and UR to the Sacramento River. Urban runoff and domestic sewage from 6,800 acres of downtown Sacramento is combined within the sewer system and diverted to the Sacramento Regional County Sanitation District wastewater treatment plant (SRCSD) (Figure 1). A majority of West Sacramento's UR is diverted to an agricultural drain that eventually reaches the North Delta at Cache Slough.

IV. METHODOLOGY

A. STUDY AREA

Stormwater drainage watersheds within and surrounding the city of Sacramento were areally divided into four domains (Table 2). Domain A (greater Sacramento) includes all watersheds outlined in Figure 1. Agricultural- and open-type lands situated in the greater Sacramento area were excluded from discharge estimates. Domain B (Sacramento proper) includes the most urbanized watersheds and, therefore, was the best estimate of the city's total runoff contribution. Domain B excludes the following watersheds (map I.D. numbers) from greater Sacramento: 1 (Laguna Creek portion (32,872 acres)); 20 (Dry Creek); 21 (Natomas East); and 45 (Aerojet). Domain C includes watersheds in which pumpage run-time had been recorded representing 72% of Sacramento proper. Domain D includes watersheds within domain C with the exception of map I.D. number 1 and represents 12% of Sacramento proper.

B. DISCHARGE VOLUMES

Urban runoff discharge volumes from domains C and D were calculated for fiscal year 1984-85 by multiplying pump run-time records by the pumpage capacity for 21 Sacramento city

Table 2. BREAKDOWN OF STORMWATER DRAINAGE SHEDS IN GREATER SACRAMENTO USED IN URBAN RUNOFF DISCHARGE AND LOADING ESTIMATES.

Urbanized Watersheds

DOMAIN 1/	ACREAGE	ACREAGE USE 2/	PERCENT OF TOTAL	WATERSHEDS EXCLUDED (MAP I.D. NUMBER) 3/
A 4/	285,006	identification of all Sacramento region watersheds	---	none
B 5/	151,029	estimated discharges and estimated loading	100	1(36% of), 20, 21, & 45
C	108,807	actual discharges with sump 90 inputs	72	10,15,16,17,18,19,20, 21,23,24,25,28,29,34, 35,36,37,38,39,40,41, 42,43,44, and 45
D	17,935	actual discharges without sump 90 inputs and UR discharge per acre per month	12	same as domain C and 1

1/ See Figure 1.
2/ Description of what the acreages were used for in this study.
3/ Refer to Figure and Table 1 for map I.D. numbers.
4/ Referred to as greater Sacramento.
5/ Referred to as Sacramento proper.

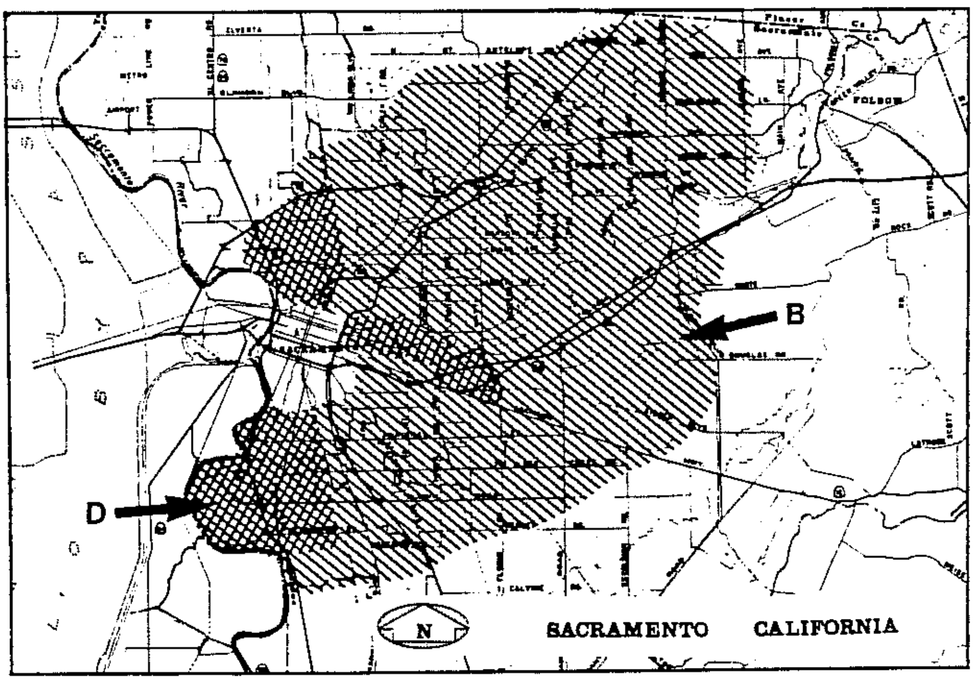

Figure 2. SACRAMENTO CITY AREAL BOUNDRIES FOR DOMAINS B AND D.

pumping stations. Only pumping stations discharging to the American and Sacramento rivers were recorded. Most pumping stations (sumps) consist of a small subsurface holding basin equipped with 1 to 7 pumps of varying pumpage capacity. Recorded pumpage volumes are hereafter referred to as "actual" discharges and represent UR pumped from either domain C or D as specified.

Sump 90 pumpage was included in the calculations because a large portion of urbanized Sacramento is drained by it as indicated by continuously high discharges. Considering the watershed makeup, discharges calculated with sump 90 inclusion (domain C, Table 2) would probably produce runoff water having a mixture of agricultural pollutants as well as pollutants from an urban origin. Calculations were also made without sump 90 discharges because of the non-urban status of a major portion of the watershed. Furthermore, there are two potential receiving waters for this watershed: the Sacramento River (into which sump 90 discharges) and a slough east of the River that eventually discharges to Snodgrass Slough. The water that is transferred from the Morrison Creek watershed to Snodgrass Slough provides irrigation water to a reclamation district that operates the pumps during the summer months (Rose, pers comm.). Since the pumps for this discharge are not metered, a true estimate of all runoff (urban or otherwise) to the Sacramento River would be difficult.

Extrapolations for Sacramento proper (domain B) discharges were made using the monthly average discharge per acre values from domain D (Table 2).

C. RIVER DILUTION

River dilution ratios (runoff volume/river volume) were estimated using monthly river volumes from the USGS Freeport (Sacramento River) and Fair Oaks Avenue (American River) gauging stations.

D. MASS LOADING

Loading estimates of copper, zinc, and lead discharged from Sacramento proper storm drains were calculated for fiscal year 1984-85. An attempt was made to separate the volume of water discharged as a direct result of rainfall and that which was discharged during dry weather periods because of their differing water quality.

Urban runoff discharged as a result of rainfall input was estimated as the product of rainfall, acreage, and an appropriate runoff coefficient (Rv). The Rv is a ratio of the volume of water coming off a watershed divided by the amount of rainfall on the same watershed (runoff to rainfall ratio). The Rv is a direct measure of the watershed's imperviousness (Griffin et al., 1980). To account for the varying imperviousness of different watersheds, Rvs of 25 and 75 % were used to present conservative and "worst case" estimates, respectively. An Rv of 75% would indicate a more developed area with correspondingly higher imperviousness producing a high ratio of runoff to rainfall.

Rainfall measurements were taken from a National Weather Service (NWS) report of monthly rainfall at 9th and O streets, Sacramento, California (Martini, 1986). Weekly rainfall was summed from NWS data sheets reporting daily rainfall from the same location.

Estimates of dry weather loading from Sacramento proper were made utilizing the recorded annual discharge volume (Domain D) extrapolated for Domain B less the wet weather input for the same area.

Metal loading estimates were calculated as the product of discharge volumes, total metal water concentrations, and the appropriate conversion factors. Wet and dry season metals concentration data were employed. Wet period concentrations for lead (144 ug/l), copper (34 ug/l), and zinc (160 ug/l) represent flow-weighted averages (median event mean concentrations) obtained from a nationwide U.S. EPA study of several storm events from 28 cities (U.S. EPA, 1983). Metal concentrations used for dry period loading calculations were obtained by averaging 2 sets of grab samples collected from 5 Sacramento storm drains during periods of no rain: copper, 20 ug/l; lead, 9 ug/l; and zinc, 280 ug/l (SCWQCL, 1979 (unpub.)).

Sacramento Regional County Sanitation District wastewater treatment plant (SRCSD POTW) loads for copper, lead, and zinc were also calculated as the product of discharge volumes (monthly averages), the average concentration of several grab samples, and the proper conversion factors. A single concentration value for copper, lead, and zinc represented the average of 11 grab samples collected throughout 1983-84 (Table A-2). For a conservative estimate, metals reported as "less than detection" were treated as not present and assigned values of zero when computing the average. Conservative loading estimates were calculated from the following concentrations: copper, 11.2 ug/l; lead, 1.5 ug/l; zinc, 75.5 ug/l. Since detection limits reflect analytical sensitivity, a value of zero may not reflect actual concentrations. Therefore, these averaged concentrations represent a conservative estimate, i.e., actual concentrations (and thus mass loads) may be higher. To account for a "worst case" situation, similar values were averaged except zero values were replaced with the concentration at the detection limit (copper, 13.9 ug/l; lead, 5.6 ug/l; zinc, 75.5) (Table A-2).

V. RESULTS AND DISCUSSION

A. STORMWATER DISCHARGES

Urban runoff (UR) water from Sacramento proper was discharged to the Sacramento and American Rivers during every month of Fiscal Year 1984-85. Monthly discharge volumes from a 17,935 acre portion of Sacramento (Domain D, Table 2) ranged from 1807 acre-feet in August to 4349 acre-feet in December (Table 3). With the inclusion of sump 90 pumpage figures (Domain C, Table 2), the peak volume of water discharged was as high as 10,960 acre-feet (December). This value represents UR water from 38% of greater Sacramento, about 6 times the acreage of Domain D. Although inclusion of sump 90 pumpage values more than doubled the peak monthly discharge volumes, the acre-feet discharged per acre was much less due to the non-urban status of a portion of the land within the sump 90 watershed. Monthly acre-feet per acre values for Domain D ranged from 0.101 to 0.242 (Table 3). These values were used to estimate monthly discharge values for Sacramento proper (domain B). The predicted volume of UR discharged monthly from domain B ranged from 15,300 (September) to 36,500 (December) acre-feet.

Much of the urban runoff water discharged was not directly attributed to precipitation since pumping occurred during

TABLE 3. ACTUAL AND PREDICTED URBAN RUNOFF DISCHARGE VOLUMES FOR THE CITY OF SACRAMENTO DURING FISCAL YEAR 1984-5.

YEAR	MONTH	MONTHLY RAINFALL (INCHES)	ACTUAL DISCHARGES (ACRE-FEET) DOMAIN C 1/	ACTUAL DISCHARGES (ACRE-FEET) DOMAIN D 2/	ACTUAL ACRE-FEET PER ACRE PER MONTH (DOMAIN D)	PREDICTED DISCHARGES (ACRE-FEET) (DOMAIN B)3/
1984	JULY	0	2451	2267	0.126	19029
	AUGUST	0.08	1808	1807	0.101	15253
	SEPTEMBER	0.08	2580	2350	0.131	19784
	OCTOBER	1.87	2976	2312	0.129	19482
	NOVEMBER	5.46	8454	4183	0.233	35189
	DECEMBER	1.75	10960	4349	0.242	36549
1985	JANUARY	1.07	4830	2968	0.165	24919
	FEBRUARY	1.85	7305	3305	0.184	27789
	MARCH	2.79	7880	3798	0.212	32018
	APRIL	0.11	3136	2465	0.137	20690
	MAY	0.02	2069	2069	0.115	17368
	JUNE	0.14	3330	3329	0.186	28091
	AVERAGE		4815	2934	0.163	24681
	SE		2918	817	0.046	6878
	TOTAL		57779	35202	---	296161

1/ WITH SUMP 90; 108,807 ACRES
2/ WITHOUT SUMP 90; 17,935 ACRES
3/ SACRAMENTO PROPER; 151,029 ACRES

months of little or no rainfall (July, August, September, and May) (Table 3). The magnitude of dry weather discharges is further evident when reviewing runoff to rainfall coefficients (Rv) for the 20 watersheds in the study area (Table 4). Over half the watersheds drained more water than fell as precipitation. The most notable of these was sump 52 which averaged over 40 times the incoming precipitation. Watersheds with lower Rvs (e.g., sump 41) reflect that these sheds are barely developed.

TABLE 4. RUNOFF COEFFICIENTS CALCULATED FOR PUMPED WATERSHEDS IN SACRAMENTO, CA, FY 1984-85.

MAP I.D. NUMBER 1/	CITY SUMP NUMBER	WATERSHED ACREAGE	TOTAL ACREAGE	RUNOFF COEFF.(%) Rv 2/
8	41	80		1
11	130	443		15
12	58	70		18
32	91	350		39
33	92	820		43
13	129	2252		53
3	28	3760		59
14	102	350	8125	59
31	109	118		106
26	99	480		127
2	34	470		135
30	95	562		145
6	63	1100		150
27	10	660		160
7	104	2220		173
22	111	419		238
4	132	1340		285
5	70	240		506
9	52	190	7799	4291
		AVERAGE		348
		MEDIAN		127
		AVERAGE WITHOUT SUMP 52		128

1/ See Figure and Table 1 for location.

2/ Rv = runoff volume/rainfall x acres x 100

There are several sources contributing to dry weather discharges including domestic and commercial irrigation and washoff, underground seepage, NPDES discharges, water table drawdown for construction, and illegal discharges. For instance, during 1985, construction of several large office buildings within the sump 52 watershed utilizing water table dewatering probably resulted in the extremely high runoff coefficient (>4000%) for that area. Furthermore, several NPDES permitted facilities discharge to the Sacramento River indirectly via the Sacramento storm drain system. For instance, Proctor and Gamble and Mather AFB discharge to Morrison Creek, McClellen AFB and Continental Chemical discharge to Arcade Creek, Rio Linda Food Products discharges to Natomas East Main Drain, and Roseville, Saber City, and Placer County all discharge to the Dry Creek Watershed. Flows greater than approximately 1 cubic foot per second were observed during periodic reconaissance of Sacramento Sumps and storm drain channels during FY 84-5. The quality of water discharged as a result of non-rainfall inputs is discussed in a latter section.

Wet period discharges were estimated utilizing runoff coefficients. Volumes calculated using Rvs have proved relatively accurate in estimating gross runoff volumes during periods of rainfall. Watersheds with static development conditions will exhibit a runoff-to-rainfall ratio (runoff coefficient (Rv)) that is linearly related to the percent of impervious surface within the watershed (Griffin et al., 1980). Utilizing that relationship, runoff can be predicted from watershed acreage and rainfall measurements. However, no known method exists for predicting dry period UR from developed watersheds. Because non-rainfall inputs represent a large portion of the total volume discharged annually, it was necessary to determine the extent of dry weather outflow.

Using regression analysis, it appears that dry period volumes comprised slightly less than half the total volume of water discharged during fiscal year 1984-85. Dry and wet period input volumes were separated utilizing regression analysis to determine the effect of precipitation on UR discharge volumes. Fifty-two percent of the volume of water discharged during each month could be explained by the precipitation input ($p<.01$). An R-squared calculated for weekly discharges during November and March was similar (0.61, $p<.01$). Assuming the R-squared values represent the volume of water discharged as a direct result of rainfall, runoff coefficients of 67 and 78% reflect the percent of rainfall runoff using monthly and weekly relationships, respectively (excluding sumps 90 and 52 discharges). Although back extrapolation to Rv's is not recommended as an exact method for determining an Rv value, regression analysis does indicate rainfall was not responsible for a significant amount of the water discharged.
Mathematical relationships exclusively utilizing regional

rainfall and percent imperviousness for predictive purposes would not provide an accurate estimate of year-round UR discharges.

Urban runoff discharges are increasing as open land areas in Sacramento continue to be developed. Past storm drain pumpage from a representative watershed shows increasing discharges over the past 16 years. Increasing runoff coefficients associated with sump 111 (Table 5) have resulted from (1) decreasing infiltration capacity, since runoff coefficients are linearly correlated with percent imperviousness (Griffin et al., 1980) and/or (2) increasing non-rainfall inputs to the watershed. Runoff coefficients for sump 104 do not show such a steady increase during the same time period possibly because the watershed is more established (Table 5). Nevertheless, as development around Sacramento increases, UR discharge volumes will also increase in proportion to the percent of the watershed that is impervious.

B. ACTUAL AND ESTIMATED DILUTION RATIOS

1. Actual and Estimated Dilution Ratios-Monthly

Urban runoff/Sacramento River (UR/SR) dilution ratios represent the percent of the River that is composed of Sacramento UR at Freeport bridge. Actual monthly UR/SR dilution percentages for domain D ranged from 0.15% (July,

Table 5. RUNOFF COEFFICIENTS FOR SACRAMENTO CITY WATERSHEDS DRAINED BY SUMPS 111 AND 104, 1969-1981 (REFER TO FIGURE 1 FOR LOCATIONS). 1/

SUMP 111 (MAP I.D. # 22)

DATE RANGE (MONTH-YEAR) FROM	TO	TOTAL RAINFALL (INCHES) 2/	RUNOFF COEFFICIENT Rv (%) 3/
8-1969	8-1970	24.71	17
8-1970	5-1973	54.9	36
5-1973	10-1974	24.96	46
10-1974	4-1977	30.44	53
4-1977	5-1978	26.12	54
5-1978	10-1979	21.41	63
10-1979	9-1980	23.08	69
9-1980	11-1981	23.21	61
11-1981	8-1982	22.56	72
8-1982	9-1984	55.05	118
9-1984	9-1985	15.78	154

Increased development ⇓ increasing runoff coefficients

SUMP 104 (MAP I.D. # 7)

9-1970	10-1971	17.69	138
10-1971	10-1974	26.17	127
10-1974	5-1977	31.2	100
5-1977	10-1979	46.77	33
10-1979	10-1980	23.12	63
10-1980	8-1982	45.73	73
8-1982	9-1984	55.05	96
9-1984	9-1986	29.83	123

more established watershed

1/ Calculated from City pump run-time records.
2/ Source: Martini, 1986.
3/ Rv = pumpage/rainfall input x 100.

1984) to 0.38% (March, 1985) (Table 6). The peak actual dilution ratio value was more than double when discharges from sump 90 were included (domain C) (0.79% compared to 0.38%). Dilution ratios within the range of 0.01 to 0.1 are considered to be potential water quality problems (U.S. EPA, 1985). March had the highest dilution ratio using actual discharges from both domain C and D; the months that followed varied between domains (Table 7). Since UR dilution ratios vary with rainfall and river flows (which are further affected by tidal fluxes), months other than those within the rainy season can be potential "worst" months. Predicted UR/SR dilution values for Sacramento proper ranged from 1.3% (July) to 3.2% (March) (Table 6; Figure 3). Therefore, during all months of the year both the actual and estimated UR/SR dilution ratios were well above the U.S. EPA 0.01-0.1% dilution range for potential water quality problems.

The percentage of Sacramento River flow composed of Sacramento urban runoff (UR/SR) exceeded similar River dilution ratios for POTW effluent during all months of this study (Table 6). The SRCSD POTW services most of greater Sacramento and is the highest volume, NPDES-permitted, discharge in the Valley. The SRCSD treatment plant discharged an average of 125 million gallons per day (MGD) during fiscal year 1984-85; the highest POTW/Sacramento River dilution ratio of 1.4% (October) was well below the peak UR/SR ratio of 3.19% (for March). The monthly dilution ratios of the SRCSD POTW effluent were also

TABLE 6. SACRAMENTO URBAN RUNOFF DILUTION IN THE SACRAMENTO AND AMERICAN RIVERS (UR/SR AND UR/AR), 1984-85.

		UR/SR DILUTION RATIO (%)			PREDICTED	ACTUAL
		ACTUAL		PREDICTED	UR/AR 4/ RATIO	SRCSD POTW/ SACRAMENTO RIVER
YEAR	DATE	DOMAIN C 1/	DOMAIN D 2/	DOMAIN B 3/	(%)	RATIO (%) 5/
1984	JULY	0.17	0.15	1.3	1.63	0.87
	AUGUST	0.17	0.17	1.46	3.26	1.07
	SEPTEMBER	0.21	0.19	1.62	4.72	1.1
	OCTOBER	0.41	0.32	2.7	4.21	1.39
	NOVEMBER	0.6	0.3	2.51	5.35	0.79
	DECEMBER	0.49	0.19	1.63	5.10	0.59
1985	JANUARY	0.52	0.32	2.71	6.18	1.07
	FEBRUARY	0.72	0.33	2.76	5.94	1.01
	MARCH	0.79	0.38	3.19	9.11	1.31
	APRIL	0.46	0.37	3.07	5.14	1.4
	MAY	0.28	0.28	2.34	2.95	1.29
	JUNE	0.35	0.35	2.96	4.40	1.4

1/ With sump 90: 108,807 acres.
2/ Without sump 90: 17,935 acres.
3/ Predicted: Sacramento proper, 151,029 acres.
4/ Predicted American River dilution ratio.
5/ SRCSD POTW= Sacramento Regional County Sanitation District treatment plant.

TABLE 7. MONTHS IN ORDER OF DECENDING DILUTION RATIOS, 1984-85.

ACTUAL SACRAMENTO RIVER	
DOMAIN C	DOMAIN D
MARCH	MARCH
FEBRUARY	APRIL
NOVEMBER	JUNE
JANUARY	FEBRUARY
DECEMBER	JANUARY
APRIL	OCTOBER
OCTOBER	NOVEMBER
JUNE	MAY
MAY	DECEMBER
SEPTEMBER	SEPTEMBER
AUGUST	AUGUST
JULY	JULY

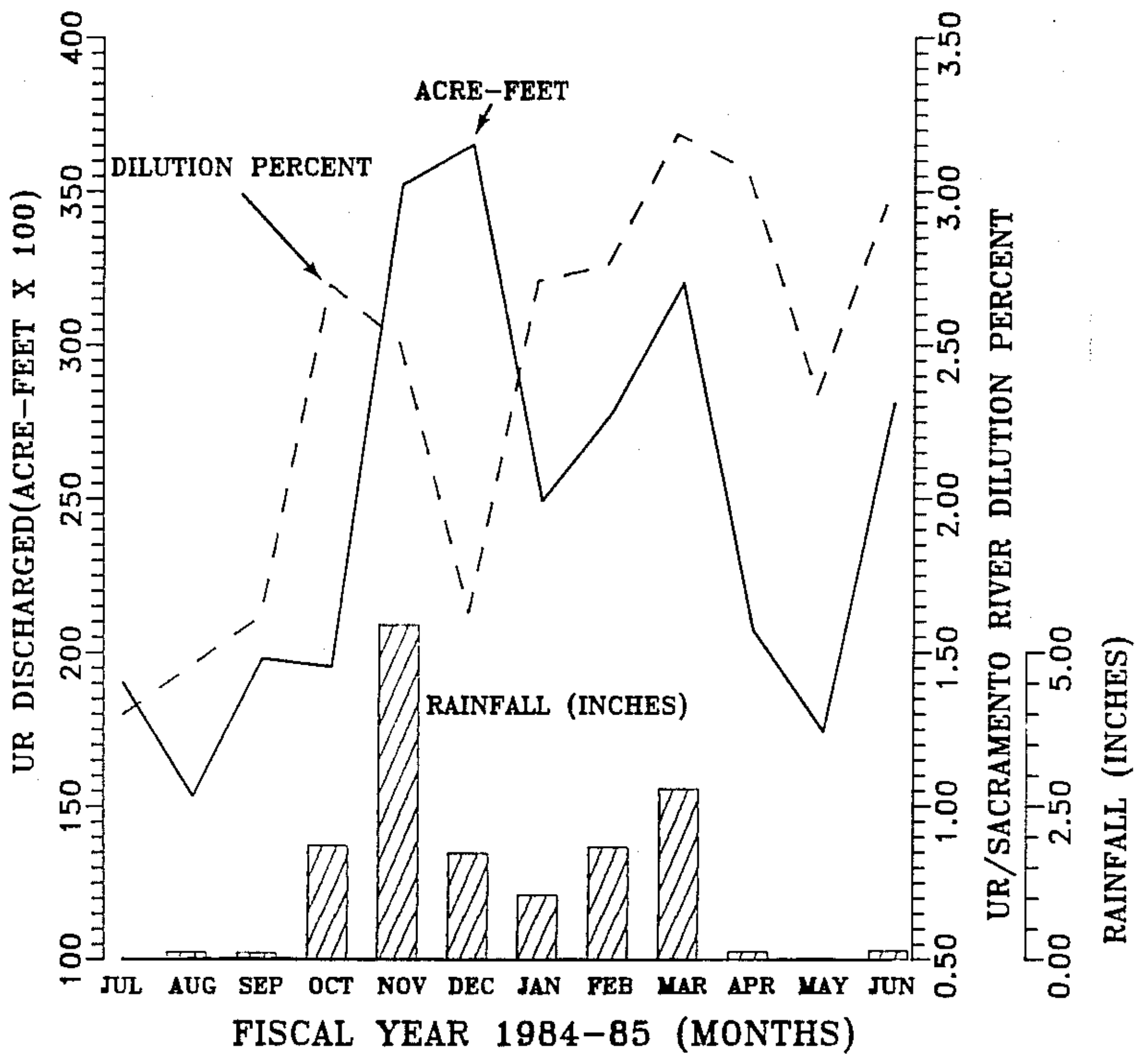

Figure 3. URBAN RUNOFF DISCHARGED FROM SACRAMENTO PROPER, RAINFALL, AND DILUTION PERCENT (URBAN RUNOFF VOLUME/SACRAMENTO RIVER VOLUME X 100) IN THE SACRAMENTO RIVER AT FREEPORT (CA), FISCAL YEAR 1984-85.

less variable, ranging between 0.59 and 1.4% (Table 6). Estimates show that urban runoff made up a larger portion of the Sacramento River at Freeport than POTW effluent during every month of FY 1984-85.

Monthly dilution calculations back to 1976 indicate that the SRCSD POTW effluent has the potential for low dilution in the Sacramento River during years of low rainfall. Using 140 MGD to represent the present effluent volume, the monthly dilution ratio was estimated to be as high as 4.60% (based on October 1977 River flow) (Table 8). As the proposed expansion of the treatment plant increases, the design flow will increase to 180 MGD (at some future date). In this case the expected secondary effluent/Sacramento River dilution ratios may reach 5.8% (Table 8). During less than normal water years, therefore, it is possible that the treatment plant/Sacramento River ratios would generally exceed average monthly UR ratios, although, the variation in UR dilution between high and low rainfall years is unknown (fiscal year 1984-85 was considered a slightly greater than average rainfall year).

2. <u>Actual and Estimated Dilution Ratios-Weekly</u>

Weekly (6 to 7 days) UR/SR dilution ratios were calculated for March and November, 1985 to determine the range and variance of dilution during shorter increments of time. The month of March was chosen because it had the highest monthly UR/SR dilution ratio during FY 1984-5. The month of November was

Table 8. ESTIMATED SACRAMENTO REGIONAL COUNTY SANITATION DISTRICT TREATMENT PLANT (SRCSD POTW) DILUTION IN THE SACRAMENTO RIVER AT FREEPORT, 1976-85.

		PERCENTAGES (%)												
PARAMETER	YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	MONTHLY AVERAGES
SRCSD POTW EFFLUENT	1985	1.27	1.21	1.49	1.70	1.59	1.60	1.33	1.58	1.75	2.18	2.04	1.33	1.59
(PRESENT 140 MGD)	1984	0.38	0.66	0.68	1.19	1.39	1.42	0.99	1.14	1.21	1.61	0.82	0.66	1.01
	1983	0.45	0.28	0.28	0.36	0.35	0.45	0.69	0.86	0.87	1.01	0.44	0.29	0.53
	1982	0.33	0.38	0.34	0.28	0.51	0.83	1.21	1.04	0.86	1.11	0.68	0.37	0.66
	1981	1.16	0.92	0.88	1.24	1.55	1.98	1.40	1.44	1.66	2.14	0.65	0.35	1.28
	1980	0.37	0.41	0.39	0.95	1.34	1.20	1.21	1.43	1.34	1.87	1.95	1.28	1.15
	1979	0.37	0.41	0.39	0.95	1.34	1.20	1.21	1.43	1.34	1.87	1.95	1.28	1.15
	1978	0.47	0.50	0.39	0.55	0.85	1.68	1.49	1.34	1.19	1.70	1.71	1.61	1.13
	1977	2.16	2.73	3.19	3.51	2.77	3.06	2.56	2.74	3.07	4.60	3.14	1.81	2.94
	1976	1.41	1.67	1.46	1.67	1.95	1.94	1.76	1.60	1.70	2.60	2.69	2.72	1.93
ANNUAL AVERAGE		0.84	0.92	0.95	1.24	1.36	1.54	1.39	1.46	1.50	2.07	1.61	1.17	1.34
SRCSD POTW EFFLUENT	1985	1.63	1.55	1.91	2.18	2.03	2.05	1.71	2.03	2.23	2.79	2.60	1.70	2.03
(PROPOSED 180 MGD)	1984	0.49	0.85	0.88	1.53	1.78	1.82	1.27	1.46	1.55	2.06	1.05	0.85	1.30
	1983	0.58	0.36	0.35	0.46	0.44	0.57	0.89	1.10	1.12	1.30	0.57	0.37	0.68
	1982	0.43	0.48	0.44	0.36	0.65	1.07	1.55	1.33	1.11	1.43	0.88	0.48	0.85
	1981	1.48	1.18	1.12	1.59	1.98	2.53	1.79	1.84	2.13	2.74	0.84	0.45	1.64
	1980	0.47	0.53	0.50	1.22	1.72	1.54	1.55	1.83	1.72	2.40	2.50	1.64	1.47
	1979	0.47	0.53	0.50	1.22	1.72	1.54	1.55	1.83	1.72	2.40	2.50	1.64	1.47
	1978	0.61	0.64	0.50	0.71	1.09	2.15	1.91	1.71	1.53	2.18	2.19	2.07	1.44
	1977	2.76	3.48	4.06	4.46	3.54	3.90	3.27	3.50	3.91	5.83	4.00	2.32	3.75
	1976	1.81	2.13	1.87	2.14	2.49	2.48	2.25	2.04	2.18	3.32	3.44	3.47	2.47
ANNUAL AVERAGE		1.07	1.17	1.21	1.59	1.74	1.97	1.77	1.87	1.92	2.64	2.05	1.50	1.71

1/ Annual Rainfall (inches) 15.22:1985; 13.01:1984; 37.62:1983; 32.15:1982; 24.57:1981; 20.01:1980; 22.33:1979; 23.58:1978; 11.39:1977; 6.67:1976.

selected to establish the effect of high rainfall on weekly dilution ratio. During periods shorter than a month, UR/SR dilution ratios fluctuate depending on River conditions and urban surface discharges. The actual weekly dilution ratios for November (Domain D) ranged from 0.15% (10-30 to 11-6) to as high as 0.82% (11-20 to 11-27); the values for March were less variable (Table 9). The percentages extrapolated for Sacramento proper neared 7% during November 20-27. It is possible for the dilution ratios to exceed 7% for periods shorter than a week assuming a back extrapolation of

TABLE 9. WEEKLY URBAN RUNOFF/SACRAMENTO RIVER (UR/SR) DILUTION RATIOS DURING MARCH AND NOVEMBER, 1985.

DATE RANGE MONTH/DAY (1985)	ACTUAL UR/SR 1/ DILUTION RATIO (%) DOMAIN C	DOMAIN D	PREDICTED UR/SR RATIO (%) DOMAIN B 2/
MARCH			
2-27 TO 3-6	0.52	0.35	2.94
3-6 TO 3-13	0.96	0.43	3.58
3-13 TO 3-20	0.88	0.34	2.88
3-20 TO 3-27	0.57	0.31	2.57
3-27 TO 4-3	0.99	0.46	3.87
AVERAGE	0.78	0.38	3.17
NOVEMBER			
10-30 TO 11-6	0.36	0.15	1.26
11-6 TO 11-13	1.11	0.43	3.62
11-13 TO 11-20	0.86	0.16	1.35
11-20 TO 11-27	1.39	0.82	6.91
11-27 TO 12-4	1.06	0.50	4.21
AVERAGE	0.96	0.41	3.47

1/ Dilution percentages calculated with pumpage from 108,807 acres (domain C) and 17,935 acres (domain D).
2/ Domain B = 151,029 acres.

increasing ratios. There are several reasons to support this. First, River flows at Sacramento do not immediately reflect region-wide rainfall runoff due to controlled water project releases and travel time through the river system. Conversely the delay period of UR discharges is shorter, decreasing the dilution potential of the River; several sumps within Sacramento begin discharging watershed rainfall runoff 15 to 60 minutes after storm initiation. Dilution is further reduced during flood tide periods when the velocity of River flow at Sacramento is affected. Therefore, during short periods of high rainfall, River flows may not increase in proportion to the runoff from Sacramento, resulting in the River receiving a "slug" of UR water.

C. WET PERIOD WATER QUALITY

1. Wet Period Water Quality-Trace Metals

Trace metals are the most common toxicant found in UR discharges and appear to be the priority pollutants that have the highest potential for threatening downstream water quality. More specifically, UR water and sediments contain significant concentrations of copper, lead, zinc and lesser amounts of nickel, arsenic, cadmium and chromium. A nationwide urban runoff study conducted by EPA (National Urban Runoff Program, NURP) concluded that trace metals (especially copper, lead, and zinc) in UR frequently exceeded EPA ambient water quality critera (U.S. EPA, 1983). The nationwide study, which monitored UR from 22 cities, reported the presence of copper, zinc and lead in over 90% of the samples collected (2300 storm events were monitored). Other trace elements, including chromium, arsenic, cadmium, and nickel, were found in 40 to 65% of the total number of samples. The NURP conclusions are consistent with limited monitoring results for the Sacramento urban storm drain system. Typical Sacramento storm drain metals concentrations are shown in Table 10. Copper, lead, cadmium, chromium, and zinc levels were relatively high, consistently exceeding acute U.S. EPA Water Quality Criteria for the protection of freshwater aquatic organisms.

Table 10. TRACE METALS IN WATER (UG/L) FROM THREE SACRAMENTO CITY STORM DRAINS, 1972-75 (ADAPTED FROM SRCSD AND SAC, 1975).

TRACE ELEMENT	RECOMMENDED CRITERIA 2/	SUMP 104 (Map ID #7) 1/ Mean	(range, n)	SUMP 111 (Map ID #21) 1/ Mean	(range, n)	ARCADE CREEK AT BRIDGE ROAD (Map ID #17) 1/ Mean	(range, n)
Arsenic	190	2.5	(<1-3.6; 28)	2.6	(1-8.2; 26)	1.6	(.4-4.2; 19)
Cadmium	0.55	6.5	(<1-90; 28)	5.6	(0-13; 26)	5.7	(2-11; 19)
Chromium (total)	11	25.9	(10-68; 28)	46.0	(9-103; 27)	34.0	(9-60; 19)
Copper	5.4	41.8	(2-100; 28)	63.0	(7-170; 27)	30.0	(10-60; 19)
Lead	0.99	395.0	(50-1040; 28)	272.0	(50-580; 27)	73.0	(10-242; 19)
Mercury	0.012	1.2	(<.1-4.6; 28)	1.2	(<.1-3.2; 27)	1.3	(.3-3.6; 19)
Nickel	74	27.0	(<10-48; 28)	48.0	(20-170; 27)	23.0	(6-46; 19)
Silver	840 3/	3.0	(0-9; 28)	3.0	(0-10; 27)	4.0	(1-11; 19)
Zinc	150 3/	258.0	(100-490; 28)	397.0	(120-1090; 27)	120.0	(32-210; 19)

1/ Map I.D. refers to Figure 1, Table 1.

2/ Ambient Water Quality Criteria (U.S. EPA) to Protect Freshwater Aquatic Life; 4-day average.

3/ One-hour average

However, because storm runoff pollutant concentrations are highly variable (somtimes ranging over 2 orders of magnitude during a single storm event), statistics representing the weighted average concentration over a storm event were calculated to compare with similar statistics from the NURP study. The event mean concentration (EMC) was used to determine an average runoff event concentration (U.S. EPA, 1976). Using the equation

$$EMC = \frac{\sum (t_{n+1} - t_n)\frac{1}{2}(C_n q_n + C_{n+1} q_{n+1})}{\sum (t_{n+1} - t_n)\frac{1}{2}(q_n + q_{n+1})}$$

where $q(t)$ = flow rate at successive time increments, and

$c(t)$ = instantaneous pollutant concentrations

discrete samples collected at sequential intervals, and combined with corresponding flow measurements, yield a flow-weighted pollutant concentration. Event mean concentration statistics were calculated for discharges from Sacramento City sump 111 during a storm event in October 1985. The EMCs for copper, lead, and zinc were compared to U.S. EPA nationwide medians (Table 11). The U.S. EPA copper and lead EMC values were similar to those calculated for sump 111. The first major storm event (0.76 inch rainfall) was monitored and may,

Table 11. COMPARISON OF NATIONAL AND SACRAMENTO EVENT MEAN CONCENTRATIONS (EMC) FOR COPPER, LEAD, AND ZINC.

TRACE METAL	U.S.EPA NATIONWIDE MEDIAN EMC (UG/L) 1/	SACRAMENTO CITY SUMP 111 EMC (UG/L) 2/
COPPER	34	34
LEAD	144	123
ZINC	160	480

1/ U.S.EPA, 1983
2/ This study

in part, be responsible for the elevated zinc levels. Although the zinc EMC was extremely high in sump 111, the overall levels of these constituents in water coming off different Sacramento watersheds are probably similar since average pollutant concentrations do not vary significantly between watersheds of differing classifications (U.S.EPA, 1983).

2. Wet Period Water Quality-Synthetic Organic Chemicals

Polynuclear aromatic hydrocarbons (PAH) are one of the most common sythetic organic chemicals associated with UR discharges. Earlier studies characterized street runoff as containing relatively high amounts of oil and grease (Bennett et al., 1984) and higher molecular weight PAH (Hoffman et al., 1982). Detectable levels of PAHs such as pyrene, phenanthrene, chrysene, and fluoranthene were reported in 10 to 16 % all water samples collected in the NURP study

(U.S.EPA, 1983). Sources of PAHs from UR include asphalt wear, automobile oil drippings, and illegal dumping of used crankcase oil (MacKenzie and Hunter, 1979; Whipple and Hunter, 1979; and Hunter et al., 1979). A complete review of petroleum products (including PAHs) in urban storm runoff can be found in ABAG, 1983, 1986.

Polynuclear aromatic hydrocarbons, similar to those found in Sacramento stormwater conveyances, have been detected in Sacramento-San Joaquin Delta/Estuary bed sediments and striped bass tissue. A single sample of Sacramento Riverbed sediment (at Collinsville) indicates the downstream presence of PAHs at low levels (Table 12). Deposition sediment was collected (instead of water) to confirm the presence of PAHs because they are known to partition readily to the particulate phase (89-98 %) (Eganhouse et al., 1981; Hoffmann et al., 1982; Hunter et al., 1979; MacKenzie and Hunter, 1979; and Zurcher et al., 1978). Furthermore, analytical precision of PAHs in stormwater has been reported to be relatively poor (Heit, 1985). Polynuclear aromatic hydrocarbons were detected at high levels in all stormwater conveyances sampled; however, they were found at highest concentrations in closed system sumps (sumps 104 and 111) where exposure to the ambient environment is limited. Potential positive detections were limited by elevated quantitation levels due to the highly polluted nature of the sediments. Conversely, no PAHs were found in any major Sacramento Valley agricultural drainage

Table 12. CONCENTRATIONS OF POLYNUCLEAR AROMATIC HYDROCARBONS (UG/KG, WET WEIGHT) IN SEDIMENT SEDIMENT FROM STORM DRAINS, AGRICULTURAL DRAINS, AND THE SACRAMENTO RIVER. 1/

SEDIMENT ORIGIN	STORM DRAIN						SACRAMENTO VALLEY AGRICULTURAL DRAINS					SACRAMENTO RIVER		FISH TISSUE 3/
SAMPLE LOCATION	MORRISON CREEK	ARCADE CREEK	SUMP-111	SUMP-111	SUMP-104	MANLOVE	COLUSA BASIN DRAIN	BUTTE SLOUGH	RD 108	NATOMAS MAIN DRAIN	SACRAMENTO SLOUGH	SACRAMENTO RIVER AT COLUSA	SACRAMENTO RIVER AT COLLINS-VILLE	STRIPED BASS (SACRAMENTO RIVER AT COLLINSVILLE)
% MOISTURE	58	29	46	58	54	36								
% ORGANIC CARBON	2.8	0.58	5.7	1.8	1.7	9								
naphthalene	<100	<100	760.0	110.0	<10000	<1000	<100	<100	<100	<100	<100	<100	<100	4
acenaphthylene	<100	<100	<2000	<100	<10000	<1000	<100	<100	<100	<100	<100	<100	<100	ND
acenaphthene	<200	<200	NA	<200	<20000	<2000	<200	<200	<200	<200	<200	<200	<200	3
fluorene	<20	<20	<2000	220.0	<2000	<200	<20	<20	<20	<20	<20	<20	<20	NA
phenanthrene	22.0	15.0	1300.0	2000.0	1400.0	280.0	<4	<4	<4	<4	<4	<4	12.0	2173
anthracene	2.5	<2	<2000	470.0	260.0	24.0	<2	<2	<2	<2	<2	<2	2.5	NA
fluoranthene	68.0	44.0	1500.0	3200.0	2400.0	720.0	<10	<10	<10	<10	<10	<10	26.0	348
pyrene	47.0	43.0	1500.0	2400.0	2600.0	580.0	<20	<20	<20	<20	<20	<20	36.0	1256
benzo(a)anthra-cene	25.0	21.0	980.0	1300.0	1200.0	380.0	<10	<10	<10	<10	<10	<10	<10	26
chrysene	<100	28.0	1300.0	1000.0	1200.0	<1000	<10	<10	<10	<10	<10	<10	19.0	128
benzo(b)fluoran-thene	28.0	25.0	900.0	970.0	750.0	270.0	<5	<5	<5	<5	<5	<5	14.0	35(b +
benzo(k)fluoran-thene	15.0	14.0	900.0	530.0	<500	170.0	<5	<5	<5	<5	<5	<5	5.4	35(b +
benzo(a)pyrene	26.0	28.0	820.0	1400.0	<1000	330.0	<10	<10	<10	<10	<10	<10	12.0	ND
dibenzo(a,h)an-thracene	<400	<40	<4000	<4000	<4000	<400	<40	<40	<40	<40	<40	<40	<40	NA
benzo(g,h,i)pery-lene	44.0	<20	<4000	<2000	<2000	<200	<20	<20	<20	<20	<20	<20	<20	NA
I-(1,2,3-cd)pyrene	40.0	40.0	<4000	1300.0	<1000	420.0	<10	<10	<10	<10	<10	<10	13.0	NA

1/ Detectable values are underlined; < = less than analytical detection; ND = not detected; and NA = not analyzed

3/ U.S.FWS, 1983 (unpublished).

sediments sampled. Other suspected sources of PAHs discharged to the Sacramento River are presently under investigation. However, preliminary results indicate that UR contributes most of the PAHs detected in downstream receiving waters. Polynuclear aromatic hydrocarbons are the present subject of a State Water Resources Control Board (SWRCB) study (Severied, pers. comm.).

Table 13 shows other U.S. EPA priority pollutants which have been detected in Sacramento storm drains and in other major effluents discharging water to the Sacramento River. Synthetic organic chemicals will be discussed here in a cursory manner here (i.e. their presence or absence noted). A followup investigation conducted by the CVRWQCB will compare the importance of UR discharges relative to permitted discharges and agricultural drains.

Data on pesticides in Sacramento UR water is scarce; however, the U.S. EPA NURP study indicates that toxaphene, chlordane, endosulfan, and alpha and gamma hexachlorocyclohexane (BHC or HCH) are the most common pesticides detected in this point source (Table 13). Water concentrations of alpha and gamma BHC have been found in all Sacramento storm drains sampled (SCWQCL, 1979(unpub.)).

Polychlorinated biphenyl compounds (PCB) have been detected at low levels in several Sacramento stormwater conveyances.

Table 13. U.S.EPA PRIORITY POLLUTANTS DETECTED IN SEDIMENT AND WATER FROM URBAN RUNOFF, AGRICULTURAL DRAINS AND THE SACRAMENTO REGIONAL COUNTY SANITATION DISTRICT WASTEWATER TREATMENT PLANT EFFLUENT (SRCSD POTW). 1/

PRIORITY POLLUTANTS DETECTED

- = NOT DETECTED + = DETECTED NA = NOT ANALYZED

CHEMICAL CLASSIFICATION AND NAME	SACRAMENTO STORM DRAINS: SEDIMENT 2/ (ug/kg, ww)	SACRAMENTO STORM DRAINS: WATER 3/ (ug/l)	NATIONWIDE STORM DRAINS: WATER 4/ (% positive)	SACRAMENTO AG. DRAINS: SEDIMENT 2/ (ug/kg, ww)	SRCSD POTW EFFLUENT: WATER 5/ (ug/l)
PESTICIDES AND PCB					
ALDRIN	- (<5,000)	- (<0.006)	+ (6)	- (<500)	- (<0.003)
BHC	- (<5,000)	+ (<0.003-0.243)	+ (15-20)	- (<500)	+ (<0.002-0.010)
CHLORDANE	- (<50,000)	- (<0.130)	+ (17)	- (<5,000)	- (<0.04)
DDE	- (<5,000)	- (<0.013)	+ (6)	- (<500)	- (<0.005)
DDT	- (<5,000)	- (<0.032)	+ (1)	- (<500)	- (<0.015)
DIELDRIN	- (<5,000)	- (<0.015)	+ (6)	- (<500)	- (<0.005)
ENDOSULFAN	- (<10,000)	- (<0.025)	+ (19)	- (<1,000)	- (<0.01)
ENDRIN	- (<10,000)	- (<0.025)	-	- (<1,000)	- (<0.010)
HEPTACHLOR	- (<5,000)	- (<0.001)	+ (6)	- (<500)	- (<0.002)
HEPTACHLOR EPOXIDE	- (<5,000)	- (<0.005)	+ (2)	- (<500)	- (<0.002)
METHOXYCHLOR	NA	- (<0.001)	NA	NA	NA
TOXAPHENE	- (<100,000)	- (<0.500)	-	- (<10,000)	- (<0.40)
PCB	+ (<25-397)	- (<0.188)	-	- (<5,000)	- (<0.04-<0.10)
VOLATILE ORGANIC CHEMICALS (HALOGENATED ALIPHATICS)					
CHLOROFORM	- (<200)	+ (<0.5-5.1)	-	NA	+ (<1.0-15.0)
METHYLENE CHLORIDE	- (<500)	- (<1.0)	-	NA	+ (1.0-8.9)
CHLOROETHANE	+ (<200-470)	- (<0.5)	-	NA	- (<5.0)
1,2-TRANS-DICHLOROETHENE	+ (<200-310)	- (<0.5)	+ (4)	NA	+ (<0.3-<13.0)
DICHLOROMETHANE	- (<200)	- (<0.5)	+ (11)	NA	NA
1,1-DICHLOROETHANE	+ (<200-150)	+ (<0.5-3.2)	+ (3)	NA	- (<2.0)
1,1-DICHLOROETHENE	- (<200)	- (<0.5)	+ (2)	NA	- (<2.0)
1,3-DICHLOROPROPENE	- (<200)	- (<0.5)	+ (2)	NA	- (<5.0)
DICHLOROBROMOMETHANE	- (<200)	+ (<0.5-0.7)	-	NA	+ (<0.4-<6.0)
1,1,1-TRICHLOROETHANE	+ (<200-150)	+ (<0.5-16.6)	+ (6)	NA	+ (<0.2-<10.0)
1,1,2-TRICHLOROETHANE	- (<200)	- (<0.5)	+ (2)	NA	- (<2.0)
TRICHLOROMETHANE	NA	- (<0.5)	+ (9)	NA	- (<2.0)
TETRACHLOROETHENE	- (<200)	- (<0.5)	+ (5)	NA	+ (0.8-<13.0)
TRICHLOROFLUOROMETHANE	- (<200)	- (<0.5)	+ (5)	NA	- (<5)
1,1,2,2-TETRACHLOROETHANE	- (<200)	- (<0.5)	+ (2)	NA	- (<6.0)
TETRACHLOROMETHANE	- (<200)	- (<0.5)	+ (3)	NA	- (<2.5)
MONOCYCLIC AROMATICS (EXCLUDING PHENOLS, CRESOLS, AND PHTHALATES)					
BENZENE	- (<200)	NA	+ (5)	NA	- (<1.0)
BENZENE, 1,2,4-TRICHLORO-	NA	NA	-	NA	- (<2.0)
BENZENE, HEXACHLORO-	NA	- (<0.5)	-	NA	- (<1.0)
BENZENE, 1,4-DICHLORO-	- (<2,000)	- (<0.5)	-	NA	+ (<1.5-<11.0)
BENZENE, CHLORO-	- (<200)	- (<0.5)	+ (5)	NA	- (<2.0)
BENZENE, ETHYL-	- (<500)	NA	+ (6)	NA	- (<2.0)
TOLUENE	+ (219-2,800)	NA	+ (3)	NA	- (<2.0)
XYLENES (TOTAL) 6/	+ (300)	NA	NA	NA	NA

Table 13. (continued)

- = NOT DETECTED + = DETECTED NA = NOT ANALYZED

CHEMICAL CLASSIFICATION AND NAME	SAMPLE ORIGIN: SACRAMENTO STORM DRAINS		NATIONWIDE STORM DRAINS	SACRAMENTO AG. DRAINS	SRCSD POTW EFFLUENT
SAMPLE PHASE	SEDIMENT 2/ (ug/kg, ww)	WATER 3/ (ug/l)	WATER 4/ (% positive)	SEDIMENT 2/ (ug/kg, ww)	WATER 5/ (ug/l)
PHTHALATE ESTERS					
PHTHALATE, BIS (2-ETHYLHEXYL)	+ (9,540-14,000)	NA	+ (22)	- (<200)	+ (<2.0-12.0)
PHTHALATE, DIETHYL	- (<2,000)	NA	+ (6)	- (<200)	- (<10)
PHTHALATE, DIMETHYL	- (<2,000)	NA	-	- (<200)	- (<1.5)
PHTHALATE, DI-N-BUTYL	+ (<2,000-170)	NA	+ (6)	+	- (<2.0)
PHTHALATE, DI-N-OCTYL	- (<2,000)	NA	+ (6)	- (<200)	- (<2.0)
PHTHALATE, BUTYL BENZYL	+ (<2,000-443)	NA	+ (6)	- (<200)	- (<2.0)
PHENOLS AND CRESOLS					
PHENOL	- (<2,000)	NA	+ (14)	- (<200)	+ (<1.5-<24.0)
PHENOL, PENTACHLORO-	- (<2,000)	NA	+ (19)	- (<200)	- (<3.5)
PHENOL, 4-NITRO-	- (<10,000)	NA	+ (10)	- (<1,000)	- (<2.0)
PHENOL, 2,4-DIMETHYL	- (<2,000)	NA	+ (8)	- (<200)	- (<2.0)
PHENOL, 4-METHYL 6/	+ (3,000)	NA	NA	NA	NA
POLYNUCLEAR AROMATIC HYDROCARBONS					
NAPTHALENE	+ (<100-760)	NA	+ (9)	- (<100)	- (<1.5)
ACENAPTHYLENE	- (<100-10,000)	NA	-	- (<100)	- (<3.5)
ACENAPHTHENE	- (<100-10,000)	NA	-	- (<200)	NA
FLUORENE	+ (<20-220.0)	NA	-	- (<20)	- (<1.0)
PHENANTHRENE	+ (15.0-2,000)	NA	+ (12)	- (<4)	- (<2.0)
ANTHRACENE	+ (<2-470)	NA	+ (7)	- (<2)	- (<2.0)
FLUORANTHENE	+ (44.0-3,200)	NA	+ (16)	- (<10)	- (<2.0)
PYRENE	+ (43.0-2,600)	NA	+ (15)	- (<20)	- (<2.0)
BENZO (A) ANTHRACENE	+ (21.0-1,300)	NA	+ (4)	- (<10)	- (<2.0)
CHRYSENE	+ (<100-1,300)	NA	+ (10)	- (<10)	- (<2.0)
BENZO (B) FLUORANTHENE	+ (25.0-970)	NA	+ (5)	- (<5)	- (<2.0)
BENZO (K) FLUORANTHENE	+ (<500-900)	NA	+ (3)	- (<5)	- (<2.0)
BENZO (A) PYRENE	+ (<1,000-1,400)	NA	+ (6)	- (<10)	- (<2.0)
DIBENZO (A,H) ANTHRACENE	- (<40-4,000)	NA	-	- (<40)	- (<2.0)
BENZO (G,H,I) PERYLENE	+ (<20.0-44.0)	NA	-	- (<20)	- (<2.0)
INDENO (1,2,3-CD) PYRENE	+ (<1,000-1,300)	NA	-	- (<10)	- (<2.0)
2-METHYLNAPHTHALENE 6/	+ (1,400)	NA	NA	NA	NA

1/ Priority pollutant Chemicals found in at least one of the 4 discharges sampled.

2/ SPSS study. Detection limits (negative detections) and concentration ranges (positive detections) reported as ug/kg (wet weight) in parentheses.

3/ SPSS study (1985-86) and Sacramento County sampling (1978-79). Detection limits (negative detections) and concentrations (positive detections) reported as ug/l in parentheses.

4/ U.S.EPA, 1983. Percent (%) of the total number of samples with detectable levels in parentheses.

5/ Quarterly self-monitoring data, 1983-85. Detection limits (negative detections) and concentration ranges (positive detections) reported as ug/l in parentheses.

6/ Not an U.S.EPA priority pollutant.

Their presence in storm drain sediment is significant due to their high bioconcentration potential and slow degradation rates. Polychlorinated biphenyls probably originate from transformer leakage within the watershed (Fujii, pers. comm.).

Volatile organic chemicals (VOC) have not been found in Sacramento UR from predominantly residential areas although several VOCs have been found in runoff from two industrial watersheds. These results corroborate EPA's conclusions that VOCs are generally restricted to industrial watershed runoff (Salo et al., 1986).

Other contaminant sources include domestic and commercial discharges of oil and other unknown chemical substances. Reports of illegal discharges to storm drains are frequently fielded by Regional Board personnel working within the Sacramento metropolitan area (Malliet, pers. comm.), and can be assumed to occur more often than reported. Discharges such as these are difficult to account for when estimating pollutant loads to the Central Valley; however, they probably should not be ignored in the future.

D. DRY PERIOD WATER QUALITY

Most trace metals present in dry weather runoff are typically at lower concentrations than storm runoff levels. Water grab

Table 14. METALS DETECTED IN 5 SEPARATE SACRAMENTO STORMWATER CONVEYANCES DURING DRY AND WET PERIODS, 1978-79. 1/

WEATHER PERIOD 2/	PARAMETER	TRACE METAL CONCENTRATION (UG/L) AS	CD	CR	CU	HG	NI	PB	ZN
DRY (N=10)	AVERAGE	9.2	0.7	15.2	20.1	0.4	43.4	8.6	280.0
	MINIMUM	0.0	0.0	1.0	3.0	0.0	0.0	1.0	0.0
	MAXIMUM	46.0	1.0	31.0	38.0	2.0	110.0	27.0	1500.0
WET (N=25)	AVERAGE	1.6	2.8	66.3	61.5	0.3	50.2	242.7	271.2
	MINIMUM	0.0	0.0	22.0	0.0	0.0	16.0	4.0	40.0
	MAXIMUM	4.0	10.0	306.0	180.0	2.2	97.0	710.0	670.0

1/ Based on grab samples taken on November 1-2 and July 20-21 (dry period) and November 12-13 and February 22 (wet period) (adapted from SCWQCL, 1979 (Unpublished)).
2/ N=number of samples analyzed.

samples from a Sacramento County study (SCWQCL, 1978 (unpub.)) collected during rainy periods were compared to similar samples collected during dry periods (Table 14). It appears that most metals are found at higher concentrations during the wet periods. The exceptions were zinc, arsenic, and mercury levels which were higher in dry period runoff. A CVRWQCB (SPSS) investigation is presently underway to better characterize dry period water quality from urban Sacramento.

E. MASS LOADING ESTIMATES

Mass loading calculations show Sacramento UR discharges are a significant source of trace metals input to the Sacramento River. The 1984-85 discharge of copper, lead, and zinc from Sacramento proper is shown in Table 15. Zinc loading (81,000 kg/year) was higher than either lead (27,000 kg/year) or copper (10,000 kg/year). Urban runoff discharged from Sacramento storm drains contributed more copper, lead, and zinc to the Sacramento River than did treated industrial/domestic wastewater from the Sacramento Regional County Sanitation District (SRCSD). This is significant since the SRCSD is the second largest volume NPDES discharger in the Valley. Comparisons were made by dividing UR metal loads (kg) by the kilograms of the same constituents discharged from the SRCSD plant (Table 16). The most notable compound was lead which exceeded conservative and worst case SRCSD loading estimates by 106 and 23 times, respectively: lead was rarely detected in the POTW effluent. Copper and zinc were similarly discharged from Sacramento area storm drains in greater amounts although the UR/SRCSD loading ratios were much less than those for lead (values ranged from 3 to 6). Therefore, even with a worst case discharge of copper, zinc, and lead from the SRCSD treatment plant, UR loading during FY 1984-85 was greater.

Table 15. MASS LOADS OF COPPER, LEAD, AND ZINC DISCHARGED FROM SACRAMENTO URBAN RUNOFF, FISCAL YEAR 1984-85.

COMPOUND	WEATHER PERIOD 1/	CONC. (UG/L)	KG DISCHARGED PER YEAR
COPPER	DRY	20	3788
	WET	34	6025
	TOTALS		9813
LEAD	DRY	9	1621
	WET	144	25519
	TOTALS		27139
ZINC	DRY	280	52768
	WET	160	28354
	TOTALS		81122

1/ A runoff coefficient of 75 % was used (see discharge volume section).

Table 16. MASS LOADING COMPARISONS OF COPPER, LEAD, AND ZINC BETWEEN SACRAMENTO URBAN RUNOFF (UR) AND THE SACRAMENTO REGIONAL WASTEWATER TREATMENT PLANT (SRCSD).

		CONSERVATIVE ESTIMATE 1/		"WORST CASE" ESTIMATE 1/	
DAILY BASELINE FLOW (MGD)	COMPOUND	CONC. (UG/L)	UR/SRCSD LOADING RATIOS 2/	CONC. (UG/L)	UR/SRCSD LOADING RATIOS 2/
125(FY 1984-85)	COPPER	11.2	5	13.9	4
	LEAD	1.5	106	5.6	29
	ZINC	75.5	6	75.5	6
140(1986)	COPPER	11.2	5	13.9	4
	LEAD	1.5	94	5.6	25
	ZINC	75.5	6	75.5	6
180(PROJECTED)	COPPER	11.2	4	13.9	3
	LEAD	1.5	73	5.6	23
	ZINC	75.5	4	75.5	4

1/ See Table A-2.

2/ Kilograms of compound discharged from urban runoff (Rv=75 %) (Table 15) divided by the kgs discharged from the Sacramento Regional treatment plant on an annual basis.

Although the loading estimates are based on limited data they are believed to be reasonably accurate. Further study is planned to verify findings. The preliminary results, however, suggest that adverse water quality impacts in the Sacramento and American Rivers may result from discharges of urban runoff.

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APPENDIX 1

U.S. ENVIRONMENTAL PROTECTION AGENCY
STORMWATER DISCHARGE PERMIT APPLICATION PROGRAM

The latest U.S. EPA regulations proposed for permitting stormwater point sources were published in August, 1985 (U.S. EPA, 50 FR 32548). The regulations would require dischargers of UR to submit a permit application. Permit application requirements have been structured in a manner similar to the NPDES application form. Both industrial facilities and municipalities owning pipes and outfalls are covered under the new permitting strategy. Submittal of discharge applications would be required by 1987 for industrial and municipal facilities and 1989 for all others.

It should be noted that this latest set of proposed regulations has followed 3 earlier attempts to regulate UR (a historical review of UR regulation development is presented in Appendix 2). The regulations presented here are only temporary; a forthcoming stormwater permit proposal is anticipated in 1987. However, a review of the latest regulations is provided here because many of the concepts will undoubtedly be retained in any future regulatory proposals (e.g., group permits and classifications, constituents to be analyzed).

REGULATION STRATEGY

Stormwater discharges are separated into 2 classifications (Group I and Group II) based on the nature of the watershed and ownership. Group I dischargers include industrial facilities as well as municipally owned outfalls. All others (e.g., parks) are classified as Group II dischargers. Both Groups must be permitted under the present proposed rules; however, the application requirements for Group I dischargers are more stringent because of their higher potential to contaminate downstream receiving waters.

Within the Group I classification, industrial facilities have the option to be covered under a comprehensive group permit. A group permit would cover all industries under a representative sub-category. The assumption is made that all industries of the same sub-category would have similar on-site operations that would result in runoff water quality reflective of the industrial operations. Differentiation of sub-categories are not explicitly defined. Trade associations representing specific industrial sub-categories would be responsible for the preparation and submittal of group permit applications. This "grouping" strategy reduces both the volume of paperwork and costs incurred by the industrial dischargers.

There are two parts to a group permit application: (1) a narrative description of all facilities covered and (2) historical or recent water quality data from a representative 10% of the sub-category (Table A-1). Depending on the size of the sub-category, the number of industries that will be monitored can vary. However, all outfalls draining a facility chosen to represent the group must be characterized. The water quality analyses required will include several conventional parameters (COD, BOD, oil and grease, pH, and TOC), any facility-specific toxicant, and any pollutant required in their NPDES effluent guidelines (if applicable) (Table A-1). Those industries not wishing to be included under this protocol, or as designated by the enforcing agency, shall submit a standard NPDES permit application package. A standard NPDES (non-stormwater) discharge permit consists of Forms 1 and 2c as required by the regulatory agency in authority.

Municipalities must also apply for a discharge permit under the newly proposed program. The application requirements are similar to those proposed for industrial facilities (Table A-1) with some exceptions. First, municipalities apparently will not be allowed to aggregate several individual outfalls into a single group permit. Secondly, just as a POTW facility regulates the effluent from private industries into its system, a similar arrangement would exist for surface runoff collection systems owned by local municipalities. In this sense, industrial outfalls discharging to a municipally maintained drainage would not be required to obtain a permit with the state, although, they will be held accountable to the municipality. A permit will not be required

Table A-1. U.S.EPA NPDES PERMIT APPLICATION REQUIREMENTS FOR URBAN RUNOFF OUTFALLS AS OF AUGUST, 1985 (50 FR 32548). 1/

GROUP	APPLICANT(S)		REQUIREMENTS 2/
I	Group application for industrial facilities in sub-categories represented by the appropriate trade association and municipalities with storm drain outfalls discharging to surface waters.	PART 1.	Description of all facilities covered A.) Geographic location B.) Range of operation C.) Size D.) Any present treatment of stormwater (including BMP's) E.) Differentiate between outfalls that discharge to receiving waters and POTW plants
		PART 2.	Historical or recent data from a representative 10% of the sub-category including the following water quality analyses: A.) Any pollutant in the effluent guidelines or NPDES permit, and as required under 40 CFR 122.21 (g)(7)(iii); and B.) 1.) TOC 4.) oil and grease 2.) COD 5.) pH 3.) BOD 6.) any suspected pollutant
	Individual industries not wanting to be covered under a group application or as designated by the permitting authority.		Standard NPDES permit application (full form 1 and 2c)
II	All other stormwater dischargers not classified as group I.		1.) NPDES form 1 2.) A narrative description defining: A.) Drainage area B.) Receiving waters C.) Any treatment applied to the discharge

1/ Application submittals are required in 1987 (Group I) and 1989 (Group II).

2/ Guidelines for acceptance of the application and further drafting of permit terms and conditions of issuance is pending future Federal Register anouncements.

of those pipes and outfalls from non-industrial areas unless one is requested by the municipality. Since major municipal stormwater conveyances collect runoff from numerous adjacent sub-watersheds, the number of these permits can be substantial. It is proposed, therefore, that the state will only be reviewing permits from industrial and major municipal outfalls discharging to surface waters.

Once the monitoring data has been submitted, the responsible agency would review the permit for completeness based on a future Federal Register announcement. Permit terms and conditions of discharge would then be issued based on loading calculations and other factors. Individual permits may be found to be more appropriate for those facilities applying under a group permit that have runoff with unique characteristics.

Presently, sanctioned mitigation measures have not been provided by EPA to help facilities reduce pollutants in their runoff to comply with permit conditions. This is because no single means of reducing runoff loads has been deemed both effective and feasible. Short of biological or chemical treatment, devices such as detention basins, swirl concentrators, recharge devices, and natural filtration (e.g., grass swales, wetlands) have been found to be effective - sometimes removing as much as 50-90 % of a number of different pollutants. However, to implement these measures, land would have to be aquired, and where land is not available, existing discharge structures would have to be modified. The potential expense of these methods could be beyond the budget of many dischargers. Less costly source control measures, such as increased street sweeping frequency, use of more effective vacuum street cleaners, and increasing public awareness, have not been shown to be as effective as outfall treatment devices (U.S.EPA, 1983).

CVRWQCB WORKLOAD INCREASE

Application review will be conducted by several municipal agencies as well as the CVRWQCB. For example, in greater Sacramento there are 6 separate entities operating and maintaining approximately 43 stormwater outfalls discharging to major surface waters. The percentage of permit applications to be processed by the Regional Board staff will vary drastically depending on the distinction betweem stormwater channels and streams. Arcade Creek, for instance, drains an approximate 26,000 acre watershed of primarily residential, commercial and somewhat industrial land-use types. The outfall discharges passively at Natomas East Main Drain (NEMD). Several industries use the creek for storm runoff drainage. A permit system may be set-up in 2 ways. First, if the confluence with NEMD is termed a municipal outfall, then one state permit would be filed and the municipality would be responsible for dischargers upstream. In the other scenario, the state would solicit all permits required within the watershed. The number of potential permittees in the Arcade Creek stream group is unknown at this time.

Presently, no definition exists to distinguish between UR conveyances and receiving waters with beneficial uses, although a suggestion has been presented in a corollary NURP study. Heaney and Huber (1984) suggest the distinction be made using water courses labeled on a USGS State Hydrologic Unit map (1:500,000). Those watercourses that do not appear on the map would be defined as storm conveyances. Only the Sacramento and American Rivers and Morrison and Dry Creeks would fall under this stream course definition.

APPENDIX 2

BACKGROUND ON EPA PROPOSED REGULATIONS TO MANAGE STORM WATER RUNOFF

Urban runoff has been a controversial issue since 1973. In that year, EPA exempted separate storm sewer discharges from NPDES permitting procedures required for all point source discharges. The agency maintained that they could more effectively deal with urban runoff if it were classified as a non-point source discharge. Storm sewer discharges fall within the definition of a point source discharge pursuant to the Clean Water Act (CWA). Because of this fact the Natural Resources Defense Council (NRDC) challenged EPA's decision in court (NRDC vs. Train) and won the suit, retracting EPA's authority to exempt point sources from the NPDES permitting system.

In response to the decision EPA published final storm water regulations in 1979-80 requiring NPDES permits for separate storm sewers defined as 1.) separate storm sewers in urbanized areas, 2.) conveyances of contaminated storm water runoff from industrial or commercial facilities and 3.) those designated by the director. The new regulations were again challanged in court, this time by numerous industry groups who asserted that most storm water discharges were not significantly deleterious to the environment and that the use of the term "contaminated" was vague and ambiguous.

After protracted negotiations with industry litigants EPA published a modification to the existing (1980) storm water provisions in 1982. The new regulations significantly reduced the scope of coverage compared to the 1980 regulations. The definition of storm water point sources was narrowed down to those conveyances contaminated by process wastes, raw materials, toxics, hazardous pollutants, and oil and grease. Furthermore, application requirements were reduced by establishing 2 groups of dischargers and eliminating monitoring for sources not likely to pose significant pollution problems.

These latest regulations generated a considerable number of comments from both the industrial sector and from environmental groups. Industry and trade associations again claimed that the proposal was not lenient enough and continued to maintain that the permit program was an inappropriate means of handling storm water runoff. Conversely, the environmental groups asserted that no data existed to support the elimination of these discharges from permit requirements. Furthermore, environmentalists stressed that the CWA mandates the permitting of point sources regardless of the level of pollutants. EPA considered these comments and published final storm water regulations on September 26, 1984 (49 FR 37998).

Revision of the 1982 regulations was basically a reversion back to the stricter regulations promulgated in 1980. The September 26, 1984 regulations comported with the legal requirements set by the CWA and the court decision of NRDC vs. Train which mandate regulation and permitting of point sources. EPA decided on more stringent regulations because no data had been submitted to prove storm water runoff to be inocuous to surface water integrity. However, the term "contaminated" had been deleted and instead the rules relied on geographic criteria. The September 26 ruling defined as a point source any storm water discharge that 1.) is located in an urbanized area, or 2.) drains from industrial or commercial lands or facilities, or 3.) is designated by the director.

The regulatory framework retained from the previous rules incorporated a two-tiered approach for classification and application procedures. Storm water point sources were classified as either group I or group II discharges. Storm water originating from an industrial plant or plant associated area, or as designated by the director, were classified as group I discharges. All other storm water point sources were classified as group II discharges. Both groups were required to submit NPDES application form 1, however, group I was also required to submit form 2c sampling and data because industrial runoff was assumed to be more hazardous. In lieu of form 2c, group II dischargers were required to submit, along with form I, a narrative description of the drainage area, receiving water, and any treatment applied to the discharge. Applications for both groups were due by April 26, 1985.

Due to apparently valid arguments from the industrial sector after promulgation of the September 26 regulations, EPA revised and published proposed alterations to the existing regulations on March 7, 1985. The most salient of the proposed changes basically lessened the burden placed on industry by reducing the application requirements for group I dischargers. Under the 3-7-1985 promulgated rules, group I dischargers would not be required to submit form 2c (sampling data) due to the complex nature of monitoring storm sewer runoff. Typical sampling problems associated with urban runoff include the immense number of discharges, an insuffcient number of laboratories to handle the surge in samples, and the unpredictability of rain storms.

The following proposed application requirements for storm water sewers were required for submittal on December 31, 1985 as stated by EPA in the proposed regulations promulgated on March 7, 1985 (50 FR 9362). Storm water dischargers were required to classify themselves as either group I or group II depending on the nature of the drainage area. Each group had separate and unique application requirements:

<u>DEFINITION</u>

Group I: All storm water conveyances draining an industrial plant or plant associated area or as designated by the director.

Application Requirements:
1.) NPDES form 1.
2.) A narrative description of A.) the drainage area, B.) the receiving waters, and C.) any treatment applied to the discharge.
3.) Any existing quantitative pollutants monitoring data specified in the proposed 40 CFR 122.21 (f)(9)(ii).
4.) Identify any pollutants listed in the proposed 40 CFR 122.21 (f)(9)(iii) that the applicant knows or has reason to believe are present in it's storm water discharge.

Group II: All other storm water discharges not classified as group I discharges.

Application Requirements:
1.) NPDES form 1.
2.) A narrative description defined for group I.

The reaction of those responding to the March 7 proposed rules was mostly favorable: only 2 out of 132 comments favored withdrawal of the proposal and retention of the existing requirements. Based on the evaluation of these comments, and a re-examination of the issues to date, EPA again re-structured its storm water runoff administrative strategy. The following is a synopsis of the regulations proposed in the 12 August 1985 Federal Register (FRL-2880-1).

In the latest (August 12) promulgated rules, EPA proposed that group I storm water discharges, identified by specific sub-category, be allowed to coalesce and apply under a single NPDES application. A trade industry representative for the sub-category would oversee submissions of several individual industry data reports that will characterize the drainage areas and the quality of water proposed to be discharged. Furthermore, EPA proposed to reclassify municipal storm water sewers from group II to group I. Finally, municipal districts will be responsible for the combined discharge of all contributers to a storm drain conveyance. These three proposed alternatives are discussed in detail below.

A.) GROUP APPLICATION REGULATIONS:

Group application for a NPDES permit is a system whereby an elected official, (possibly a representative of a trade association) representing several dischargers of a specific sub-category, submits data and application requirements characteristic of all dischargers. All group I storm water point sources must submit either an individual application for a NPDES permit or be covered by an approved storm water group application. This group application procedure only applies to states with non-approved NPDES programs, however, permit approved states may adopt the group application procedure (amending present regulations) if they so desire. A group application would represent industrial facilities of the same sub-category as defined in the CFR (40 subchapter N). A group applicant (sub-category) would be issued a general or individual permit if specific discharge criteria are met as determined by the EPA or states with approved permit systems. Applicants requesting to be covered under a group permit would be given a chance to comply (if their submission is deficient) prior to the final decision if corrections can be made in an expeditious mannor.

Requirements:

PART 1

Each facility requesting to be included under a group permit in a specified sub-category, must submit all or part of the following:

1.) A Notice of Intent stating a desire to be covered under a group permit.
2.) A discription of the range of operation, size, and geographic location.
3.) Indicate whether or not the facility treats their stormwater ("treatment" includes BMP's).
4.) Indicate whether the storm water runoff is dischrged to a POTW or directly to surface waters.

PART 2

Part 2 of the group application would consist of representative quantitative data from facilities within the sub-category. Each facility chosen for sampling under the group application would test for:

1.) Any pollutant limited in an effluent guideline for its sub-category.
2.) Any pollutant tested in the facility's NPDES permit for its process wastewater.
3.) Oil and grease, TOC, COD, pH, and BOD.
4.) Any information on the discharge required under 40 CFR 122.21 (g)(7)(iii); and
5.) Form 1 application.

B.) MUNICIPAL STORM WATER SEWERS:

Municipal storm water sewers will be re-classified as group I storm water point sources (see March 7 proposed rules). The ruling was determined based, in part, on measurements of storm water runoff consisting of high BOD and TSS levels reported to be, respectively, equal to and 10 times above secondary treatment wastwater. Furthermore, freshwater chronic standards were typically exceeded for lead, copper, zinc, and to some extent cadmium in storm runoff water.

C.) DISCHARGES INTO MUNICIPAL STORM WATER SEWERS:

Municipalities will be required to permit their storm water outfalls regardless of contributers, relieving all dischargers into the system of the responsibility of having to obtain individual permits. However, the permitter would retain the authority to designate such dischargers as copermittees or require individual permits.

Table A-2. METALS CONCENTRATIONS IN SECONDARY EFFLUENT FROM THE SACRAMENTO REGIONAL COUNTY SANITATION DISTRICT TREATMENT PLANT, 1983-4 (ADAPTED FROM EFFINGER, 1984).

YEAR	1983								1984			
MONTH-DAY	5-31	6-20	7-26	8-24	9-19	10-24	11-22	12-19	1-17	2-21	3-19	
COMPOUND 2/	CONCENTRATION (UG/L) 1/											AVERAGE
arsenic (<5)	0	6	0	5	0	0	0	0	0	0	0	1.0
cadmium (<1)	0	0	0	0	0	0	0	0	0	0	0	0.0
chromium, T(<5)	8	7	8	10	12	12	0	8	0	0	8	6.6
copper (<10)	10	19	16	14	14	13	19	0	0	0	18	11.2
(worst case) 3/	10	19	16	14	14	13	19	10	10	10	18	13.9
lead (<5)	0	0	9	0	0	8	0	0	0	0	0	1.5
(worst case) 3/	5	5	9	5	5	8	5	5	5	5	5	5.6
nickel (<5)	11	6	15	9	6	0	0	10	10	0	0	6.1
zinc (<5)	52	52	62	75	80	130	79	62	81	69	89	75.5

1/ Zeros represent values reported as less than detection.

2/ Laboratory analytical detection limits in parentheses.

3/ Worst case levels were the same except less than detection values (zero) were replaced the detection limit values.